

**AGE DETERMINATIONS AND EARTH-BASED MULTISPECTRAL OBSERVATIONS OF LUNAR LIGHT PLAINS;** U. Koehler, R. Jaumann, G. Neukum; German Aerospace Research Establishment (DLR), Inst. for Planetary Exploration, Berlin/Oberpfaffenhofen, Germany.

**Introduction:** The history of Light plains still remains doubtful, but there are good arguments – mainly obtained by age determinations and supported by multispectral observations – for an endogenic (magmatic) instead of an (exclusively) impact related origin.

Light plains are characterised by smooth areas with an albedo lower than the surrounding highlands (12 - 13 %), but significantly higher than maria (5 - 6 %). Before Apollo 16 a volcanic source has been supposed, but analysis of returned samples (highly brecciated and metamorphosed rocks) favoured an impact ejecta related origin. Among the currently discussed models are (a) formation by ejecta sedimentation from multi-ringed basins <sup>[1]</sup>, (b) formation by secondary and tertiary cratering action of ballistically ejected material during the formation of multi-ringed basins <sup>[2]</sup>, (c) in situ formation by impact melt of large events <sup>[3]</sup>, and (d) preare (crypto-) volcanism basalts covered by a thin ejecta cover <sup>[4, 5]</sup>; younger impacts penetrated the ejecta surface to create the dark haloed craters. To find arguments in favour or against these ideas the chronology of light plains is of major importance. Obviously a genetic relationship between the evolution of light plains and the basin forming impacts can be possible only if the events of emplacement features happened simultaneously.

Age determinations can be performed by interpreting lunar crater size-frequency distribution measurements. Earlier investigations <sup>[6]</sup> led to the conclusion that some light plains in the surroundings of the Orientale and Imbrium basin are neither of same age nor can their origin be exclusively attributed to two specific epochs (i. e. Orientale and Imbrium events). Another important observation are variations in age even in the very vicinity of the basins. For example, in the NE rim of the Imbrium basin light plains decrease in age from N to NE; plains near the Apollo 16 landing site ( $3.8 - 3.9 \cdot 10^9$  a) are older than those  $10^\circ$  more to the W ( $3.6 - 3.8 \cdot 10^9$  a), followed again by older plains in and around crater Ptolemaeus and the Fra Mauro area ( $3.8 - 3.9 \cdot 10^9$  a; <sup>[7]</sup>). We have performed more age determinations of lunar light plains, and the results seem to reconfirm that a) there are plains certainly younger than the last basin forming event of the Orientale impact – thus making it impossible to explain their origin by impact ejecta –, and b) many ages show no or only weak correlation with the Orientale or Imbrium event.

Another aim was to investigate possible dependences between the age of light plains and their chemical-mineralogical composition to get hints about the evolution of the plains' surfaces. To extend the Apollo 16 spectral informations we used these data as a calibration standard for our earth based spectral and photometrical data. We performed telescopic lunar observations at the Mauna Kea Observatory/Hawaii in 1983 in six and 1989 with the DLR CCD camera in

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12 narrow band filters (bandwidth = 20 nm) in the visible and near IR wavelengths. Data underwent reduction, and effects induced by the atmosphere have been eliminated. To remove effects caused by different viewing angles we applied a differentiated photometric correction based on the model of Hapke [8] for bright, intermediate and dark areas respectively [9].

The data have been correlated with a spectral-chemical model derived from laboratory measurements. This model enables us to define spectral surface units and their respective geochemical composition in terms of wt% of Ti-, Fe-, Al- and Ca-oxides [10]. One result of our first observation campaign are different FeO-contents with values between 3 and 12 wt%, showing us mineralogical variations of light plains. Even a tendency towards decreasing FeO-numbers from W to E in the central nearside terrae can be observed, but no definite geographical correlation with the age variations of the respective plains mentioned above. The data obtained with 12 filters in 1989 reconfirmed these results by analysing the content of TiO<sub>2</sub>.

We can summarise that an impact related origin of light plains cannot be denied, but it certainly was not the only involved process. There are arguments in favour of a magmatic origin of light plains. Most convincing for a volcanic source is the fact, that there are light plains clearly dated younger than the Orientale event. If it's true that light plains are of magmatic origin, this would imply dark mare volcanism occurring over a period of time parallel to the less mafic volcanism of the terrae-like light plains, and that there existed regional variations in magma composition. More detailed spectral information and more age determinations are needed to obtain arguments for further discussions. Galileo Earth/Moon-2 encounter data include high resolution multispectral information of areas poorly covered by earth based observations. These data may be helpful in answering questions about light plains.

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